SECTION 26 08 01

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

This Section includes commissioning (Cx) process requirements for the following electrical components, systems, assemblies, and equipment.

a. High-voltage distribution equipment, including the following:

(1) Circuit breakers.

(2) Disconnect switches.

(3) Instrument transformers.

(4) Rigid buswork.

(5) Surge arrestors.

(6) Grounding systems.

(7) Protective relays.

(8) Power transformers.

b. Medium-voltage generation and distribution equipment, including the following:

(1) Medium-voltage generators and control system.

(2) Protective relays and circuit breakers.

(3) Power Quality Monitoring System (PQMS) equipment.

(4) Switchgear.

(5) Power Transformers.

(6) Instrument Transformers.

(7) Grounding Systems.

(8) DC Station Battery Systems.

(9) Medium-voltage power cables.

(10) Medium-voltage switches.

(11) Medium-voltage surge protective devices.

c. Low-voltage electrical equipment and grounding systems, including the following:

(1) Secondary unit substations.

(2) Motor control centers (MCCs).

(3) Switchgear and switchboard assemblies.

(4) Protective relays and circuit breakers.

(5) Distribution and branch-circuit panelboards.

(6) Transfer switches.

(7) Uninterruptible Power Supply (UPS) and inverter systems.

(8) Lightning protection systems.

(9) Grounding systems.

(10) Power Quality Monitoring System (PQMS) equipment.

(11) Power transformers.

(12) Variable Frequency Drives (VFDs).

(13) DC Station Battery Systems.

(14) Low-voltage power cables.

(15) Heat-trace control systems.

(16) Electrical feeders and branch circuits.

(17) Instrument transformers.

(18) Motor starters.

(19) Surge protective devices.

(20) Metering devices.

(21) Ground-fault protection systems.

(22) Receptacles and devices.

(23) Low-voltage generators and control systems.

(24) AC battery systems and chargers.

(25) DC Station Battery Systems.

(26) UPS systems.

(27) General and egress lighting.

(28) Site and area lighting.

c. Controls and instrumentation, including the following:

(1) Equipment monitoring systems.

(2) Energy monitoring and control systems.

(3) Electrical metering system.

(4) Lighting control systems.

(6) Heat-trace control systems.

(7) Emergency Power Off (EPO) systems.

e. Inter-system testing and verification.

1.2 RELATED REQUIREMENTS

Refer to Section 01 91 00.01 15 COMMISSIONING for general Cx process requirements, definition of Cx team members, and delineation of responsibilities.

Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for acceptance tests for electrical systems specified in Division 26.

1.3 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA 90	(2015) Standard for Commissioning Building Electrical Systems

1.4 DEFINITIONS

1.4.1 BoD

Basis-of-Design Document, as defined in Section 01 91 00.01 15 COMMISSIONING.

1.4.2 Cx

Commissioning, as defined in Section 01 91 00.01 15 COMMISSIONING.

1.4.3 CxA

Commissioning Authority, as defined in Section 01 91 00.01 15 COMMISSIONING.

1.4.4 CxC

AM#9... Commissioning Specialist for Construction**...AM#9**, as defined in Section 01 91 00.01 15 COMMISSIONING.

1.4.5 CxG

USACE Commissioning Specialist, as defined in Section 01 91 00.01 15 COMMISSIONING.

1.4.6 CCR

Contractor's Commissioning Representative, as defined in Section 01 91 00.01 15 COMMISSIONING.

1.4.7 Low Voltage

600 V and below.

1.4.8 Medium Voltage

601 V and above.

1.4.9 High Voltage

69,001 V and above.

1.4.10 Normal Power Systems

A power system that provides primary power to a facility.

1.4.11 OPR

Owner's Project Requirements, as defined in Section 01 91 00.01 15 COMMISSIONING.

1.4.12 Systems, Assemblies, Subsystems, Equipment, and Components

Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submittals with an "S" designation following the “G” are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29.01 00 SUSTAINABILITY REPORTING. Other designations following the "G" designation identify the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00.01 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Construction Checklist Review; G, CBJM

SD-07 Certificates

Testing Equipment and Instrumentation
Equipment Manufacturers' Proprietary Instrumentation and Tools

1.6 CONSTRUCTION CHECKLISTS

Draft construction checklists created by CxA will be provided for Contractor review prior to creation and distribution of the final Construction Checklists. Final versions will incorporate Contractor comments and information on approved submittals.

Provide comments to the material, installation, and performance test checklists for systems, assemblies, subsystems, equipment, and components to be part of the Cx process and according to requirements in Section 01 91 00.01 15 COMMISSIONING.

Construction Checklists shall include, but are not limited to, installation checks, startup, performance test, and performance test demonstration as described in the following:

a. Equipment testing and inspection procedures, not including optional tests, described in NETA ATS.

b. Equipment verification, pre-functional, and functional performance tests described in NECA 90.

c. Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING.

d. Testing and verification requirements of the Division 26 technical specifications and manufacturers' startup and testing checklists.

1.7 QUALITY ASSURANCE

1.7.1 Testing Equipment and Instrumentation Quality and Calibration

Testing equipment and instrumentation shall be:

a. Capable of testing and measuring performance within the specified acceptance criteria.

b. Calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.

c. Maintained in good repair and operating condition throughout duration of use on Project.

d. Recalibrated/repaired if dropped or damaged in any way since last calibrated.

Submit a list of test equipment and instrumentation. For each piece of equipment or instrument, identify the following:

a. Equipment/instrument identification number.

b. Planned Cx application or use.

c. Manufacturer, make, model, and serial number.

d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

1.7.1.1 Equipment Manufacturers' Proprietary Instrumentation and Tools

For each instrument or tool, identify the following:

(1) Instrument or tool identification number.

(2) Equipment schedule designation of equipment for which the instrument or tool is required.

(3) Manufacturer, make, model, and serial number.

(4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

Electrical proprietary test instrumentation and tools become property of the Government at the time of Substantial Completion.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 CONSTRUCTION CHECKLIST REVIEW

Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor. Return draft construction checklist review comments within 10 days of receipt.

When review comments have been resolved, the CxA will provide final construction checklists, marked "Approved for Use, (date)." Use only construction checklists marked "Approved for Use, (date)."

3.2 COMMISSIONING TESTING PREPARATION

Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved shop drawings and submittals.

Certify that electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved shop drawings and submittals, and that pretest set points have been recorded.

Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency, and alarm conditions).

3.3 COMMISSIONING TEST CONDITIONS

Perform tests using design conditions, whenever possible. Simulated conditions may, with approval of the Contracting Officer, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments.

Provide equipment to simulate loads. Set simulated conditions as directed by CxA and document simulated conditions and methods of simulation.

After tests, return configurations and settings to normal operating conditions. Cx test procedures may direct that set points be altered when simulating conditions is impractical. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to the Contracting Officer. After deficiencies are resolved, reschedule tests.

If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 COMMISSIONING TESTS BY CxA FOR ELECTRICAL SYSTEMS

Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response according to acceptance criteria.

Coordinate schedule with, and perform Cx activities at the direction of, CxG.

Comply with construction checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying electrical systems and equipment.

Provide technicians, instrumentation, tools, and equipment to perform and document the following:

a. Construction checklist verification tests.

b. Construction checklist verification test demonstrations.

c. Cx functional tests.

d. Cx functional test demonstrations.

3.4.1 Verification of Medium-Voltage Distribution, Protection, and Monitoring System Installation and Operation

Prerequisites	
	Acceptance of results of acceptance test reports specified in Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for components and systems to be tested.
Components and Systems To Be Tested	

	Switchgear, protective relays and circuit breakers, power transformers, instrument transformers, Power Quality and Monitor System (PQMS) equipment, grounding system components, surge protective devices.
Test Purpose	
	Verify installation and operation of medium-voltage power distribution system.
Test Conditions	
	Energize components of medium-voltage primary and distribution system and test operation and parameters of equipment.
Acceptance Criteria	
	Successful completion of all tests and verifications required by Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING and Electrical Cx Construction Checklist and Functional Performance Tests.

3.4.1.1 Medium-Voltage Distribution, Protection, and Monitoring System Training Requirements

Contractor shall provide minimum 16 hours integrated systems training in accordance with Section 01 78 23.01 00 OPERATION AND MAINTENANCE DATA and Section 01 91 00.01 15 COMMISSIONING in addition to special training requirements and durations listed in Sections 25 10 11.01 00 POWER CONTROL AND MONITORING SYSTEM (PCMS), 26 09 13.01 00 POWER QUALITY MONITORING SYSTEM (PQMS), and 26 11 14.01 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION.

3.4.2 Verification of Medium-Voltage Generation and Control System Installation and Operation

Prerequisites	
	Acceptance of results of acceptance test reports specified in Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for components and systems to be tested.
	Completion of medium-voltage distribution, protection, and monitoring system installation and operation verification tests.
Components and Systems To Be Tested	
	Generator and control system, generator protection and monitoring equipment.
Test Purpose	

	Verify installation and operation of medium-voltage power generation and control systems.
Test Conditions	
	Energize components of medium-voltage generation and control system and test operation and parameters of equipment.
Acceptance Criteria	
	Successful completion of all tests and verifications required by Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING and Electrical Cx Construction Checklist and Functional Performance Tests.

3.4.2.1 Medium-Voltage Generation and Control System Training Requirements

Contractor shall provide minimum 16 hours integrated systems training in accordance with Section 01 78 23.01 00 OPERATION AND MAINTENANCE DATA and Section 01 91 00.01 15 COMMISSIONING in addition to special training requirements and durations listed in Sections 25 10 11.01 00 POWER CONTROL AND MONITORING SYSTEM (PCMS), 26 09 13.01 00 POWER QUALITY MONITORING SYSTEM (PQMS), and 26 32 15.01 10 SUBSTATION INTERIM DIESEL-GENERATOR SET STATIONARY 1000-4000 KW, WITH AUXILIARIES.

3.4.3 Verification of Motor Control Center (MCC) Installation and Operation

Prerequisites	
	Acceptance of results of acceptance test reports specified in Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for components and systems to be tested.
	Completion of installation, startup, and testing of motors and loads to be served by MCC equipment.
Components and Systems To Be Tested	
	Motor control center (MCC) assemblies, circuit breakers, MCC mounted motor starting and variable frequency control equipment, motor circuit protection.
Test Purpose	
	Verify installation and operation of MCCs and MCC mounted control equipment.
Test Conditions	
	Energize components of MCCs and test operation and parameters of equipment.
Acceptance Criteria	

	Successful completion of all tests and verifications required by Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING and Electrical Cx Construction Checklist and Functional Performance Tests.

3.4.3.1 Motor Control Center (MCC) Training Requirements

Contractor shall provide minimum 4 hours integrated systems training in accordance with Section 01 78 23.01 00 OPERATION AND MAINTENANCE DATA and Section 01 91 00.01 15 COMMISSIONING in addition to special training requirements and durations listed in Section 26 29 23.01 00 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS.

3.4.4 Verification of Low-Voltage Power Distribution and Protection System Installation and Operation

Prerequisites	
	Acceptance of results of acceptance test reports specified in Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for components and systems to be tested.
Components and Systems To Be Tested	
	Switchgear assemblies, distribution panelboards, circuit breakers (enclosed and panel-mounted), protective relays, power transfer switches, PQMS protection and monitoring equipment, power metering and data logging, motor starters and circuit protectors, surge protective devices, and ground-fault protection systems.
Test Purpose	
	Verify installation and operation of power distribution and protection equipment.
Test Conditions	
	Energize components of power distribution equipment and test operation and parameters of equipment.
Acceptance Criteria	
	Successful completion of all tests and verifications required by Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING and Electrical Cx Construction Checklist and Functional Performance Tests.

3.4.4.1 Low-Voltage Distribution and Protection System Training Requirements

Contractor shall provide minimum 16 hours integrated systems training in accordance with Section 01 78 23.01 00 OPERATION AND MAINTENANCE DATA and Section 01 91 00.01 15 COMMISSIONING in addition to special training requirements and durations listed in Sections 25 10 11.01 00 POWER CONTROL AND MONITORING SYSTEM (PCMS) and 26 09 13.01 00 POWER QUALITY MONITORING SYSTEM (PQMS).

3.4.5 Verification of High-Voltage Power Distribution, Protection, and Monitoring System Installation and Operation

Prerequisites	
	Acceptance of results of acceptance test reports specified in Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for components and systems to be tested.
Components and Systems To Be Tested	
	Protective relays and circuit breakers, power transformers, instrument transformers, Power Quality and Monitor System (PQMS) equipment, grounding system components, surge protective devices, disconnect switches, rigid buswork.
Test Purpose	
	Verify installation and operation of high-voltage power distribution system.
Test Conditions	
	Energize components of high-voltage primary and distribution system and test operation and parameters of equipment.
Acceptance Criteria	
	Successful completion of all tests and verifications required by Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING and Electrical Cx Construction Checklist and Functional Performance Tests.

3.4.5.1 High-Voltage Distribution, Protection, and Monitoring System Training Requirements

Contractor shall provide minimum 16 hours integrated systems training in accordance with Section 01 78 23.01 00 OPERATION AND MAINTENANCE DATA and Section 01 91 00.01 15 COMMISSIONING in addition to special training requirements and durations listed in Sections 25 10 11.01 00 POWER CONTROL AND MONITORING SYSTEM (PCMS), 26 09 13.01 00 POWER QUALITY MONITORING SYSTEM (PQMS), and 26 11 14.01 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION.

3.4.6 Verification of Battery, Inverter, and UPS System Installation and Operation

Prerequisites	
	Acceptance of results of acceptance test reports specified in Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for components and systems to be tested.

Components and Systems To Be Tested	
	DC battery cabinets, battery charging and monitoring equipment, AC inverters, AC and DC power distribution units (PDUs), circuit breakers and maintenance bypass devices, Power Quality and Monitor System (PQMS) interfaces, battery-powered uninterruptable power supplies (UPS) systems.
Test Purpose	
	Verify installation and operation of battery, inverter, and UPS systems.
Test Conditions	
	Energize components of system and test operation and parameters of equipment.
Acceptance Criteria	
	Successful completion of all tests and verifications required by Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING and Electrical Cx Construction Checklist and Functional Performance Tests.

3.4.6.1 Battery, Inverter, and UPS System Training Requirements

Contractor shall provide minimum 6 hours integrated systems training in accordance with Section 01 78 23.01 00 OPERATION AND MAINTENANCE DATA and Section 01 91 00.01 15 COMMISSIONING in addition to special training requirements and durations listed in Section 26 32 33.01 10 UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM ABOVE 15 KVA CAPACITY.

3.4.7 Verification of Low-Voltage Motor Starting and Control Equipment Installation and Operation

Prerequisites	
	Acceptance of results of acceptance test reports specified in Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for components and systems to be tested.
	Completion of installation, startup, and testing of motors and loads to be served by equipment.
Components and Systems To Be Tested	
	Variable frequency drives (VFDs), motor starters, motor circuit protectors, control interfaces to other systems (PCMS, security, BMS, FA).
Test Purpose	
	Verify installation and operation of starting and control equipment.
Test Conditions	

	Energize components of starting and control equipment and test operation and parameters.
Acceptance Criteria	
	Successful completion of all tests and verifications required by Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING and Electrical Cx Construction Checklist and Functional Performance Tests.

3.4.7.1 Low-Voltage Motor Starting and Control Equipment Training Requirements

Contractor shall provide minimum 6 hours integrated systems training in accordance with Section 01 78 23.01 00 OPERATION AND MAINTENANCE DATA and Section 01 91 00.01 15 COMMISSIONING in addition to special training requirements and durations listed in Section 25 10 11.01 00 POWER CONTROL AND MONITORING SYSTEM (PCMS).

3.4.8 Verification of Instrument and Control Equipment Installation and Operation

Prerequisites	
	Acceptance of results of acceptance test reports specified in Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for components and systems to be tested.
	Completion of installation, startup, and testing of loads and devices to be monitored, metered, or controlled by equipment.
Components and Systems To Be Tested	
	Equipment monitoring systems, energy monitoring and control systems, electrical metering system, emergency power off (EPO) systems, heat trace control equipment.
Test Purpose	
	Verify installation and operation of instrumentation and control equipment.
Test Conditions	
	Energize loads and devices to be controlled or monitored, and test operation and parameters of control and monitoring equipment through all expected loads and conditions.
Acceptance Criteria	
	Successful completion of all tests and verifications required by Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING and Electrical Cx Construction Checklist and Functional Performance Tests.

3.4.8.1 Instrumentation and Control Equipment Training Requirements

Contractor shall provide minimum 6 hours integrated systems training in accordance with Section 01 78 23.01 00 OPERATION AND MAINTENANCE DATA and Section 01 91 00.01 15 COMMISSIONING in addition to special training requirements and durations listed in Section 26 29 23.01 00 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS.

3.4.9 Verification of General and Egress Lighting and Control Equipment Installation and Operation

Prerequisites	
	Acceptance of results of acceptance test reports specified in Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING for components and systems to be tested.
Components and Systems To Be Tested	
	General illumination luminaires, task illumination luminaires, egress luminaires, building-mounted site and area luminaires, pole-mounted site and area luminaires, lighting controls, lighting control interfaces to other systems (PCMS, security, BMS, FA).
Test Purpose	
	Verify installation and operation of lighting and control equipment.
Test Conditions	
	Energize components of starting and control equipment and test operation and parameters.
Acceptance Criteria	
	Successful completion of all tests and verifications required by Section 26 08 00.01 00 APPARATUS INSPECTION AND TESTING and Electrical Cx Construction Checklist and Functional Performance Tests.

3.4.9.1 General and Egress Lighting and Control Equipment Training Requirements

Contractor shall provide minimum 16 hours integrated systems training in accordance with Section 01 78 23.01 00 OPERATION AND MAINTENANCE DATA and Section 01 91 00.01 15 COMMISSIONING to cover programming, maintenance, operation, and system architecture for lighting and control systems.

3.5 COMMISSIONING TESTS BY THIRD-PARTY CERTIFIERS FOR ELECTRICAL SYSTEMS

Engage a third-party testing and certification agency to perform tests and inspections of systems listed below.

Coordinate schedule with, and perform testing activities at the direction of, CxG.

Comply with construction checklist requirements, including material verification, installation checks, startup, and performance test prerequisites below.

Provide technicians, instrumentation, tools, and equipment to assist the third-party testing agency perform and document the following.

3.5.1 Third-Party Verification of Lightning Protection System

Prerequisites	
	Completion of installation and testing of interconnected building grounding system components.
Components and Systems To Be Tested	
	Lightning protection system components including, but not limited to, air terminals, ground rods, connection fittings.
Test Purpose	
	Verify installation and certification of lightning protection system.
Acceptance Criteria	
	Successful completion of all tests and verifications required by Section 26 41 00.01 00 LIGHTNING PROTECTION SYSTEM.

-- End of Section --